# EVN + MERLIN observations of 3C66B

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**Abstract**

We present observations of the FRI radiogalaxy 3C66B during a joint EVN + MERLIN VLBI session in May 1995. The jet is mapped from the 5 mas scale up to about 3 arcmin. The newly mapped VLBI jet shows essentially two elongated blobs in the direction of the brightest kpc jet (NE). We interpret these two blobs in the light of a new model for VLBI jet making use of the two-fluid concept.

## 1 Introduction

The radiogalaxy 3C66B has several very attractive features. It is a large FRI radiosource of about 100 kpc total extension (Leahy et al. 1986; Hardcastle et al. 1996), relatively close to us (1 arcsec $\simeq$ 420 pc for $H_0 = 75$ km s$^{-1}$ Mpc$^{-1}$). It shows two jets with the brightest of them being one of the 6 synchrotron optical extragalactic jets known (Butcher et al. 1980; Fraix-Burnet et al. 1989a, b; Fraix-Burnet 1997). The detailed structure of the jet is characterized by a double-stranded structure (Macchetto et al. 1991) with a perfect correspondance between the optical and radio emissions (Jackson et al. 1993). It is then rather different from M87 where, grossly speaking, there seems to be only one wiggling filament, and 3C273 where the optical synchrotron emission is much more concentrated on the ridge line of the jet than the radio emission.

But certainly the main distinctive characteristics of 3C66B among the optical jets is that this is the only radiosource showing a double-sided jet. And indeed Fraix-Burnet (1997) might have detected the optical counterpart of the radio counterjet. The conclusion of 3C66B being the first *double-sided optical* jet is not definitive yet, but the synchrotron spectra of the jet and counterjet have been shown to be intrinsically different (Fraix-Burnet 1997).

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## 2 Observations

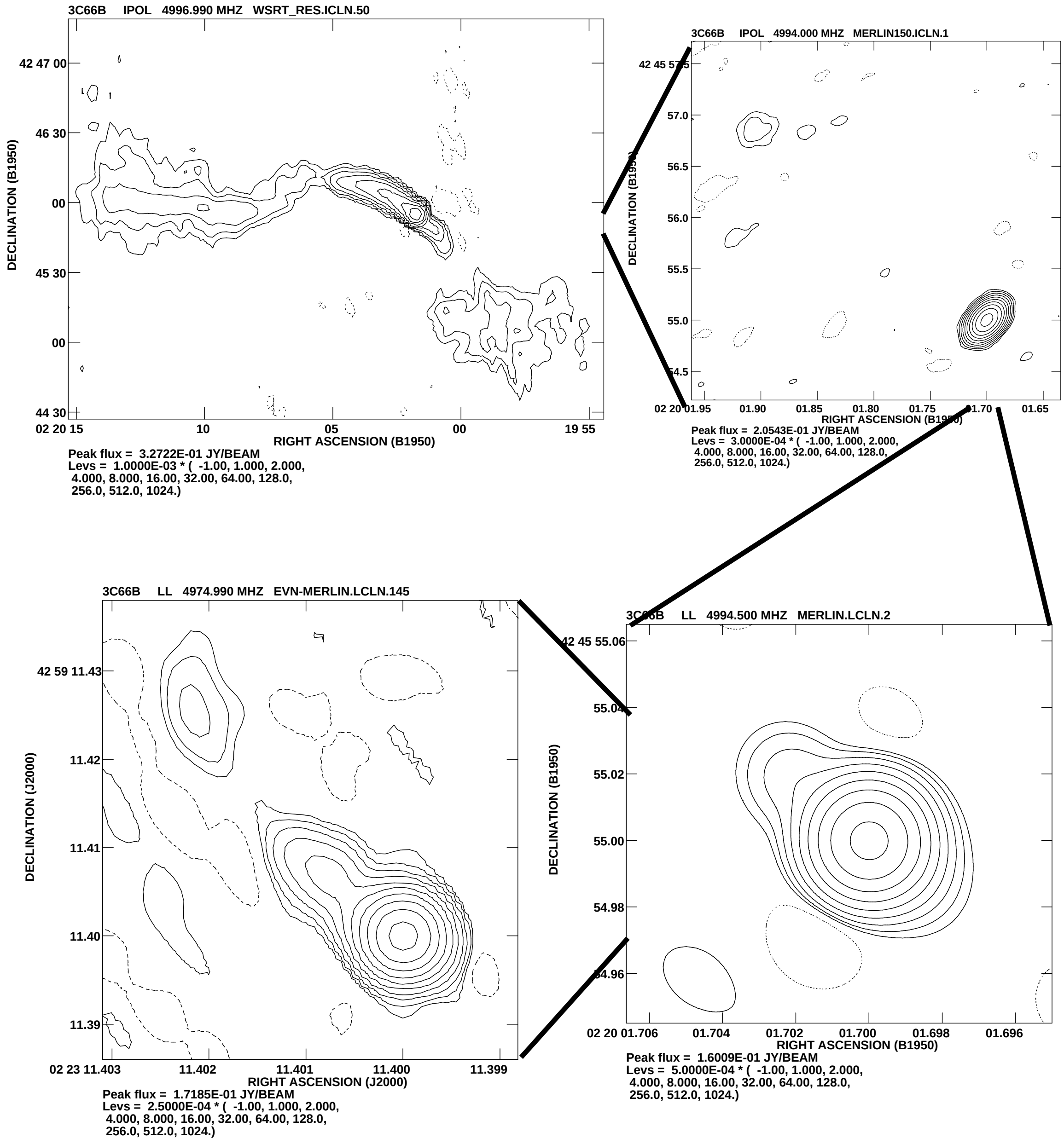
The main goals of our VLBI observations of 3C66B was to see if any pc-scale jet did exist and to map it at the best resolution as possible. The proposal was asking for 12 antennas of the EVN array and some affiliated telescopes, and took advantage of the joint session with MERLIN to map the transition region between the known kpc-scale jet and the VLBI jet. Unfortunately, we lost all the long baselines due to technical problems and also to scheduling mishaps. However, the 7 antennas plus MERLIN and Westerbork arrays did provide the first mapping of 3C66B from a few mas up to several arcmin. The observations took place on May 21st, 1995, but the data were only correlated in June 1996!

About 7 arcmin to the NW, there is a strong ponctual radiosource 3C66A. One of the secondary lobe rings fell on the center of 3C66B. This compelled us to remove the CLEAN components associated with 3C66A on the Westerbork and MERLIN data. The relative calibration between MERLIN and EVN data was not eased by the fact that the Cambridge antenna did not provide VLBI data on all the May, 1995 session, so that the common baseline between the two arrays was lost. Fitting the levels of the visibilities using the calibrator DA193 yield a ratio of 1.1 between MERLIN and EVN data.

## 3 Results

Four maps were made and are shown in the figure. The WSRT array provides a map of the whole radiogalaxy with a resolution of 5 arcsec. The MERLIN map at a resolution of 150 mas shows an unresolved core together with the brightest component of the jet, i.e. knot B at 2.9 arcsec from the nucleus (Fraix-Burnet et al 1989a; Hardcastle et al. 1996). An over-resolved MERLIN map at a resolution of 20 mas shows a NE 35 mas ($\simeq$ 15 pc) extension in the nucleus. This extension shows up as a distinct component on the EVN+MERLIN map (resolution of 5 mas) and is not seen on an EVN-only map. There is another component closer to the nucleus (15 mas $\simeq$ 6 pc) which points exactly in the direction of the large scale jet.

Because of the lost of long baselines, not much can be said about the structure of the blobs. They seem to be elongated in the direction of the jet and very probably connected by a bridge of emission. By fitting elliptical gaussians to the three components (the core and the two blobs at 15 and 35 mas), flux densities are found to be respectively 180, 11 and 3 mJy.

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## 4 Two-fluid model for VLBI jets

What is the nature of VLBI knots? One idea is that they are shock waves accelerating the radiating particles (see for instance Gómez et al. 1994). Despringre and Fraix-Burnet (1997) proposed a new interpretation using the concept of the two-fluid model developed for different parts of extragalactic jets (Sol et al. 1989; Pelletier and Roland 1986, 1988; Achatz et al., 1990, 1992; Fraix-Burnet and Pelletier 1991; Fraix-Burnet 1992; Pelletier and Sol 1992). Highly energetic electrons and positrons are associated with $\gamma$-ray bursts, forming "clouds" of relativistic particles accelerated essentially along the MHD jet outward (Marcowith et al. 1995). The MHD jet can be considered as a wind from the accretion disk and is the bulk jet seen at the kpc scale. Hence our interpretation is that the VLBI blobs correspond to the clouds of relativistic electron-positron pairs ejected outward after a $\gamma$-ray bursts. Despringre and Fraix-Burnet (1997) made a first set of simulations showing that this model can easily reproduce the VLBI observations, such as the wiggling motions and apparent speeds. The intensity of the blobs are derived from the physical characteristics of the particles, which are constrained by $\gamma$-ray emission model. A second step (in progress) is the modelisation of the observed polarisation with a turbulent magnetic field.

The last step of this modelisation will be to study the physical evolution of the 'clouds' of relativistic electron-positron pairs as they propagate from the $\gamma$-ray region ($10^{-2} - 10^{-3}$ pc) outward along the jet. The shape and radiation properties of these clouds will then be compared with the VLBI observations. The elongated shapes of the two blobs seen in 3C66B are intuitively consistent with our two-fluid model.

## 5 Conclusion

These EVN+MERLIN observations of 3C66B have revealed a new pc-scale jet. This jet is associated with a very interesting source, so it now deserves a more detailed study. In light of the model presented in Sect. 4 (Despringre and Fraix-Burnet 1997), multifrequency, polarisation and multiepoch observations of 3C66B are now necessary to probe the physics of this pc-scale jet, and also of the other VLBI jets.

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